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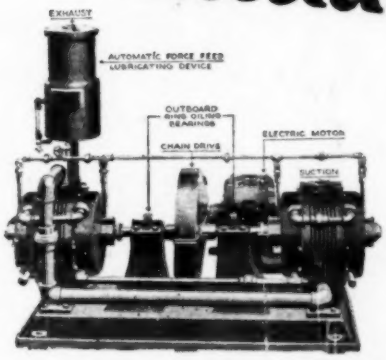

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OIL & FAT INDUSTRIES, Vol. V, No. 10, October, 1928. A monthly journal published by Russell Palmer at 420 Madison Ave., New York, N. Y. Subscription, $3.00 the year, domestic $4.00, foreign. Entered at the Post Office, New York, December 31, 1925, as second class matter under act of March 3, 1879.

OIL & FAT INDUSTRIES

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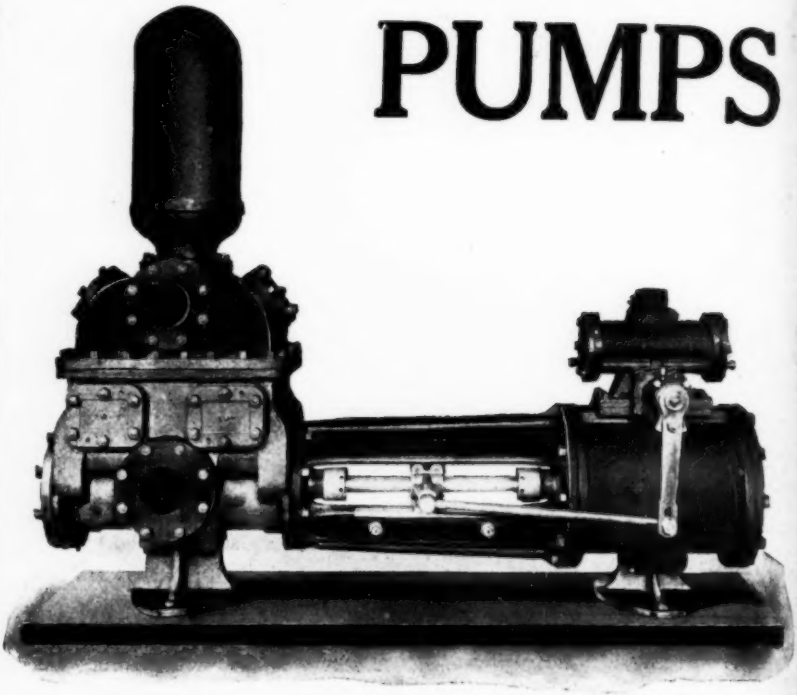

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OIL & FAT INDUSTRIES

VOLUME V OCTOBER, 1928 NUMBER 10

Crude Oil Filtration Has Arrived

Editorial

IN our persistent advocacy of filtration of crude cotton seed oil we have addressed our remarks more largely to the oil miller, the one who has been the primarily interested party, who has been able to apply the methods involved to the manufacturing operations of his plant. The crusade has been received with favor in some quarters and with lack of appreciation in others, even among some of the millers who would have benefited by filtration of their crude oil.

Among the refiners there was at first division of opinion, but we are happy to state that reports which reach us from sources in contact with the leading refiners of the country show that these progressive manufacturers have been quick to appreciate the many advantages to them of 'Filtered Crude.' Within the last few days we have received a confidential report originating in one of the largest refinery organizations in the country in which the advantages of 'Filtered Crude' cotton seed oil, more particularly crude which has been treated in the course of filtration with an adsorbent carbon material, are set forth as follows:

1. Consistent, though slight, reduction in F.F.A. shown after filtration with adsorbent carbon.
2. Consistent reduction in refining loss.
3. Consistent reduction in color of the refined oil.
4. Consistent increase in the bleachability of the refined oil.
5. Consistent improvement in the flavor and odor of both filtered crude and refined oil made from it.

Here is the refiner's answer to those reactionary people, wherever they may be found, who would deny to the cotton seed oil miller the advantages of advancement in technology in his industry.

It seems to us unnecessary to dilate upon this terse summary of the advantages of progress as outlined by a conservative business organization, interested solely in quality and profits.

We feel safe in predicting that before three seasons have passed unfiltered crude cottonseed oil will have disappeared from the market.

Those millers who are alive to the trend of markets will hasten to equip their plants with the necessary apparatus to produce filtered oil.

Fall Meeting Promises Instructive Discussion of Soap Chemistry

THE second fall meeting of the American Oil Chemists' Society will be held at New York City on Thursday and Friday, October 25 and 26.

The first business meeting will be held at the New York Produce Exchange and will be called to order at 10:00 A. M. Thursday, October 25th in the Board of Managers' Room, Lackawanna floor.

The business meeting on Friday will be held at the Hotel McAlpin and will conclude the business sessions.

There will be meetings of the various committees of the Society on both Thursday and Friday afternoons.

The committee of New York members in charge of the meeting consists of H. P. Trevithick, Chairman, Miss Rosalind Norris, M. H. Ittner, A. P. Lee, W. A. Peterson, A. W. Thomas, B. H. Thurman and David Wesson.

The chief address at present scheduled will be delivered by Mr. J. L. Beatty, President, New York Produce Exchange, in welcoming the members to New York. The papers to be presented will be mainly devoted to the chemistry and technology of soap and of its by-products. As this is the first meeting of the American Oil Chemists' Society at which the soap-making features of oil chemistry will be in predominance, the attendance of all soap manufacturers and chemists, whether members of this Society or not, is strongly urged.

The tentative outline of the papers to be presented follows:

How a Technical Soap Section Can Help the Soap Industry; R. C. Edlund, Executive Manager, Association of Soap & Glycerine Producers.

Coloring Soap; S. N. Cummings, Pylam Products Company.

Metallic Soaps; M. F. Lauro, Bureau of Chemistry, N.Y.P.E.

Report of Color Vision Test Made in New Orleans; I. G. Priest, Chief Colorimetry Division, Bureau of Standards.

Gibbs' Law of Adsorption and its Significance in Emulsions, Froths and Foams; Dr. Arthur W. Thomas, Professor of Chemistry, Columbia University.

Emulsions Containing Alkaline Earth Stearates; A. P. Lee and John E. Rutzler, Jr.

A Talk on Soaps; A. K. Church, Chief Chemist, Lever Brothers Company, Cambridge, Mass.

Spontaneous Heating of Oils and Fats; Norman J. Thompson, Chief of Laboratories, Associated Factory Mutual Fire Insurance Companies of Boston.

Report of Some Mackey Tests Made on Vegetable Oil; Herman Aspergren, Vice President, Portsmouth Cotton Oil Refining Corp.

The Use of Fats in Baking; Dr. M. C. Graff, Baker Research Department, Procter & Gamble Company.

New Developments in Distillation of Glycerine; Oscar Wurster.

Soap; Dr. Martin H. Ittner.

Triethanolamine in the Manufacture of Soaps; By a representative of Carbide and Chemicals Corp.

The Atlas Electric Devices Co. will show washing machines.

Soyabean Oil Industry in Manchuria

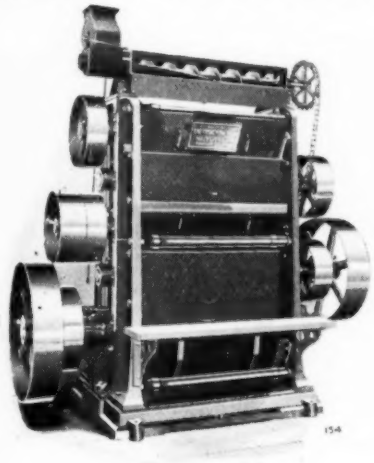
A Review of Pressing and Extraction Methods in the Far East

BY M. NEUMUNZ, M. E.

IN the September issue of OIL AND FAT INDUSTRIES, Mr. E. Govier gives us some information on the European methods of crushing Soyabeans. In this connection it may be opportune for the writer to relate some of his experiences pertaining to the Bean Oil Industry, particularly as observed during his stay in South Manchuria some seven years ago.

Solvent Extraction Popular in Europe

The description Mr. Govier gives of the equipment used in Europe seems to indicate that it is of English manufacture, but it is doubtful if at the present time there are many mills to be found in Europe which are still using hydraulic presses for extracting Soyabean oil; at least when the writer was in Europe in 1922 the more important mills had all adopted the chemical extraction process, on account of the greater yield of oil obtainable when solvents are used.



Crushing Rolls †

† *Illustrations courtesy of French Oil Mill Machinery Co.*

I had the opportunity of visiting the STETTINER OELWERKE, STETTIN, Germany, and also The DANSKE SOYAKAGEFABRIK, COPENHAGEN, Denmark*. The Danskesoyakagefabrik, at one time, had 32 plate presses of the type mentioned by Mr. Govier, for pressing soyabeans; now however they use a German built Extraction Plant which gives them a yield of 17 per cent of oil when dealing with 250-300 tons of beans every twenty-four hours. Their loss of benzine is only 1 per cent based on the raw material handled. Inasmuch as all the beans have to be imported, it stands to reason that it is more profitable to extract the oil with solvents than by the use of presses, particularly in European countries where highly skilled labor is available at low cost, including the services of expert chemists and chemical engineers. To operate a chemical extraction plant successfully it is indispensable to carefully supervise at all times the working of the machinery and to keep the same in first class condition so that solvent loss is kept at

*Both these concerns are among the largest producers of soyabean oil on the European continent and now use chemical extractors in preference to hydraulic presses. It can be said, incidentally, that soyabeans are one of the very few oil bearing materials which can be dealt with successfully in a chemical extraction plant.

a minimum and all operations are carried out as minutely as in a chemical laboratory. In this country we find that extraction plants have been unable to compete with the simpler and more reliable pressing method, which observation applies even more to foreign countries such as the Far East, where bean oil production is classed among the most important manufactures.

Pressing Plants in Manchuria

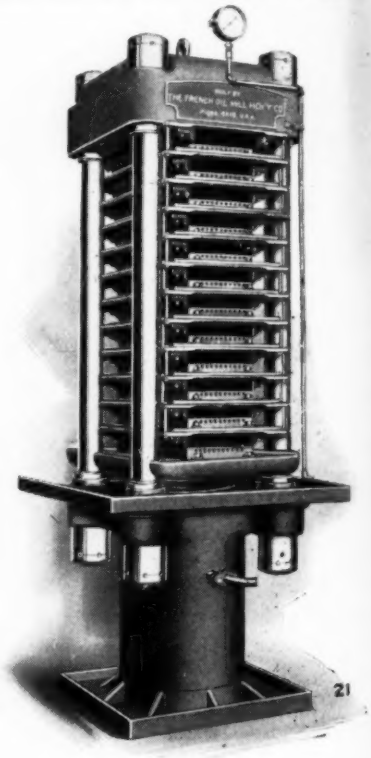
I was called upon in 1920 to design and equip two large Soyabean Oil Mills, one being erected in Yokohama and the other in Dairen, S. Manchuria. All the press room machinery was furnished by a large American manufacturer and in 1921-1922 I had the opportunity of visiting both mills which had been operated only a short time, but which were giving very good results. The presses used were and are standard cotton seed box presses, as shown in cut, which have proven to be far superior for soya bean pressing to the open Anglo-American plate presses as built by European manufacturers.

The mills in Dairen and Yokohama were equipped with French 4-high Vertical Automatic Continuous Cookers, each feeding a hydraulic automatic former which molded cakes for 6 16-Box Presses. Automatic Cake Strippers and Trimmers were installed to remove the press cloth and trim or pare the short oily sides of the cakes.

The great advantage a box press has over Anglo-American plate presses is the fact that the long sides of the cakes are hard and do not need trimming or paring, the short ends only being soft and oily, also the press cloth cannot creep the way it does with open plate presses. Press cloth consumption is thus greatly reduced with the use of the box presses.

Cleaning Equipment

For cleaning the beans, we installed a Howes Elevator Separator, working in conjunction with a magnetic separator to eliminate any iron and other metal, which are always found among the beans. The beans were reduced and ground into coarse meal in Bauer Bros. motor driven Attrition Mills and then further ground and flaked in standard French 5-high Crushing Rolls, the same style as are used in all the cottonseed oil mills in this country.

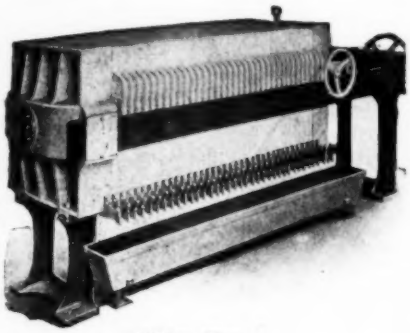


Box Press

The pressed oil was of course immediately filtered and sold as crude oil, although part of it was

subjected to a refining process and converted into edible oil, of which large quantities were and still are exported to Europe.

We found that the necessary weight for forming one cake was not much less than 20 lbs., a 16-



Filter Press

box press being capable of holding about 310 lbs. of material. A press was filled twice every hour and left 25-27 minutes under pressure, yielding from 40-44 lbs. of oil. The cakes from one press would weigh 250-260 lbs. We got thus a yield or crude oil of 13-14 per cent which was considered very good in view of the fact that in the old mills, using locally built presses and machinery the yield was rarely over 10 per cent.

Some Chinese Accounting

While the oil extraction left nothing to be desired, we were confronted with one difficulty and objection which was hard to overcome, namely the fact that one ton of beans would not produce the same amount of oil and cake as previously. In the Chinese way of crushing beans, there is no cleaning process. The resulting cake contains up to 15 and more per cent of oil, the tendency being to add as large a quantity of water as possible so as to increase the weight of the cake and make the sale more profitable. With our American machinery we were compelled to thoroughly clean the raw material, removing all dust, impurities and metallic parts, which cleaning process resulted in a loss of 5 per cent in weight. The slab cake made on our presses would contain from 9-10 per cent of moisture and it was not possible or feasible to increase this moisture content to any extent without seriously damaging the press cloth. For these reasons, when the tonnage of oil and cake produced in a month was totalled up, there was a shortage of anything from 5-10 per cent based on the weight of beans bought. Our Chinese and Japanese customers found this rather a drawback, as they had been accustomed to get 102-103 tons of oil and cake out of every 100 tons of beans.

Even so, they found the greater yield of oil far offset any loss in weight of oil and cake compared

Power Cake Stripper

to the quantity of beans delivered to the mill, and as far as the writer knows our machinery has been in continuous operation for the last seven or eight years, and having received no complaint whatever from the users, we can assume it to be giving good results and entire satisfaction.

The Coloring Matter of Cottonseed Hulls

Reporting the Isolation of a New Substance from the Hulls

BY AUGUSTUS H. GILL and H. W. GREENUP

WHILE it is not difficult to remove the color from cottonseed oil, it is far from an easy matter to identify it; it was thought therefore that a study of the coloring matter in the seed hulls might throw some light on the colors in the oil itself.

Little is known of these coloring matters even though considerable work has been done on them. Palmer[1] says that the coloring matter of the crude oil consists of carotin and related pigments, and his statement has some proof in the work carried on by Priest[2] of the Bureau of Standards. However, this is in opposition to work carried on by Gill[3] who has shown that the Crampton-Simons test for palm oil is caused by the carotin present in the oil. If carotin be added to cottonseed oil the Crampton-Simons test will be given. As the oil does not give this test without the addition of carotin it is fairly evident that carotin is not present. Further work by the Bureau of Standards[4] has shown that crude oil contains resins which will combine with caustic soda to increase the refining loss. However, the same article states that no gossypol is found, even though Marchlewski[5] first isolated it from the soap stock produced by the refining. This is probably due to the difference in manner of obtaining the oil from the seed. For, according to Withers and Carruth[6], gossypol is held in the kernels from which the oil is pressed, if the kernels be first heated as in the case of hot pressed oil. However, in the case of cold pressed oil, gossypol comes out with the oil.

Marchlewski appears to be the only investigator who has done much work on the foots. The fatty acids from the foots when distilled under diminished pressure leave a residue in the still from which no coloring matter has been isolated.

No references to work on hulls were found in the literature although a thorough search was made. In fact, all the important work seems to have been, with the exception of Marchlewski's work, on the cottonseed meal. In this material the amount of oil present is not great enough to cause serious difficulties. The most important work has been done by Withers and Carruth.

Coloring Matter

A. The most common coloring matters found in plants are as follows:

1. Carotin ($C_{40}H_{56}$) a red crystalline solid found in carrots, orange peel and palm oil[7], butter fat, some leaves, etc. Melting point of this substance is

[1] "Carotin and Related Pigments." L. S. Palmer.
[2] Unpublished work.
[3] Color Test for Oils. Gill.
[4] Cotton Oil Press (No. 5) 29.
[5] J. Prakt. Chem. 60 89-90 (1899).
[6] J. Agri. Research 5 (261) (1915).
[7] Color Test for Oils. J. Ind. and Eng. Chem. 10 612 (1918).

168°C., it is unsaturated and is characterized by the blue color which it gives when dissolved in concentrated sulfuric acid and by its absorption spectra. The structural formula for carotin is unknown even though considerable work has been done on it. It absorbs Iodine forming $C_{40}H_{56}I_2$. It crystallizes from carbon disulfide solution in which it has a deep red color.

2. Lycopin ($C_{40}H_{56}$) is an isomer of carotin and can be separated from it by its removal from petrolic ether solution by methyl alcohol. It also gives characteristic absorption spectra. As in the case of carotin its structural formula is unknown and it forms an iodine addition product.
3. Xanthophyll is a closely related pigment with a yellow color. It is best dissolved by methyl alcohol from which it can be readily crystallized. It is precipitated from alcoholic solution by adding water.
4. Fucoxanthin is another related pigment and is separable by its solubility in methyl alcohol.
5. Chlorophyll is the common green pigment found in green leaves, grass and many green plants. It can be separated from the other coloring materials by precipitation from ether solution with alcoholic caustic soda or potash.
6. Gossypol. This is the yellow coloring material isolated from cottonseed foods by Marchlewski[8]. It was also found in cottonseed meal by Withers and Carruth[9] who proved it to be the toxic substance present. They made an alcoholic extract of the meal, evaporated and dissolved it in ether. From this they precipitated it by adding aniline.

Analysis of Foots

B. Method of analysis of the foots and its result:

1. The soap stock was completely saponified to remove the excess of oil by adding alcoholic caustic soda solution and heating. The completely saponified material was dissolved in alcohol and thoroughly dried in an oven at 100°.
2. The dried material was extracted with ether for several hours. The ether extract, when washed with water and acidified slightly, proved to be colorless.
3. The residue from the extraction was dissolved in water and 36° Be. salt solution was added. The soap was salted out and the dark aqueous solution below was acidified. This was then evaporated to dryness and the residue dissolved in alcohol. However the material was in the form of a gum from which nothing could be crystallized. Aniline when added formed no crystalline material so there was evidently no gossypol in this portion of the foots.
4. The salted out soap was then dried and extracted with ether, carbon disulfide, petrolic ether, benzene and acetone successively, but no coloring material was present in the extract.
5. The residue was dissolved in water, acidified and treated with lead acetate. The resulting lead soaps were extracted with ether. This removed the soaps of oleic and linolic acid

[8] J. Prakt. Chem. 60 89-90 (1899).
[9] J. Agri. Research 5 261 (1915).

and all the coloring matter as the residue was colorless. This extract was dried and in turn extracted with benzene and carbon disulfide, but the coloring matter was not removed.

6. The residue was again dissolved in water acidified and calcium hydroxide added in excess. The resulting calcium soaps were extracted with acetone, benzene, ether and carbon disulfide, but, as before, no coloring matter was extracted even after extraction lasting as long as forty-eight hours.
7. The fatty acids were again split out by dissolving the soap from the above procedure in water, acidifying, and boiling. The fatty acids were then agitated with decolorizing carbon but an insufficient amount of the color was removed in this manner to warrant continuation of this method of procedure.

From this work it appears that separation of the coloring matter from the soap stock by either plain extraction with organic solvents or by extraction of the lead or calcium salts of the fatty acids is not feasible, owing to the greater solubility of the coloring matter in the soap itself or in the fatty acids split out by acidifying the soap.

Hull Coloring Matter

C. Analysis of the coloring matter from cottonseed hulls.

In this analysis the complications due to the presence of oil or fatty acids encountered in the work on foots or oil were negligible, owing to the very small amount of oil present in the hulls.

The hulls were extracted with various solvents in periods ranging from a few hours to two weeks. The apparatus consisted of a large flask containing the solvent, inside of which were suspended the hulls enclosed in a white cloth bag. This was heated under a return condenser and afterwards the extract was filtered. The following solvents were used:

(a). alcohol; (b) ether; (c) carbon disulfide; (d) water. The water extract was by far the most colored and the carbon disulfide next. The alcohol and ether extracts were only faintly colored yellow and were treated as follows: (According to Palmer[10].)

(a) The first part was evaporated under diminished pressure and dissolved in ether. It was then shaken with alcoholic caustic potash which saponified the small amount of oil which was present. The ether extract was then evaporated and dissolved in petrolic ether. This was washed with 100cc. of 80%, 100cc. of 85%, and two 50cc. portions of 90% methyl alcohol. According to Palmer the carotin would be in the petrolic ether solution and xanthophyll in alcohol solution. Both of these were transferred to carbon disulfide and examined spectroscopically according to the method of Formanek[11]. The alcohol solution gave no absorption spectrum and the petrolic ether solution which was in carbon disulfide when compared to carotin extracted from carrots did not resemble it at all.

The results of this method were checked by using a tube tightly packed with dried calcium

[10] "Carotin and related Pigments." L. S. Palmer.

[11] "Spektral Analytische Noichweis Kunstliche Organische Farbstoffe."

carbonate and running the solutions, which had previously been combined, through it according to the method recommended by Palmer. The results given were the same, as no different colored bands were found by this method.

(b) The second portion was transferred to ether and aniline added to the amount of one fifth of the bulk of the small ether solution. This was warmed and set aside. After three days crystals were observed. These crystals according to the method of Withers and Carruth[12], were heated with alcoholic potash, and dissolved in water. The solution was acidified and the precipitate dried. Its melting point was 136°. This was acetylated by heating with acetic anhydride and allowing the acetylated product to crystallize from the acetic anhydride. The crystals so obtained were needle shaped and had a melting point of 220°. This (a and b) proves the absence of carotin and xanthophyll and the presence of gossypol in the hulls. However, the quantity of gossypol present is exceedingly small as about fifteen pounds of hulls were extracted and the amount of the aniline product obtained was less than one gram. The toxic effect of this small amount would be negligible.

D. Analysis of the water extract from cottonseed hulls.

This extract was made in the same manner as the previous extracts, the extraction being continued for four days. At the end of this time it was filtered and evaporated to small bulk. A small portion was dried completely but it absorbed oxygen and darkened with this process. The remaining portion was poured into a large volume of alcohol from which it precipitated in a reddish brown flocculent form. Repeated extraction with alcohol and ether gave a reddish brown powder. All efforts to crystallize this substance from alcohol, ether, carbon disulfide, benzene, petrolic ether, acids and bases were vain. The only solvents in which it was soluble were water and dilute acids and bases. Glacial acetic acid would not dissolve the substance. It was impossible to crystallize this substance from water for the amorphous form always separated out when the solution was evaporated to small bulk and allowed to stand.

A systematic analysis of the substance according to Mulliken[13] was made and the results would not fit any compound mentioned by him; also no compound was found in the literature which would fit these reactions. The analysis with its results was as follows:

1. A melting point determination on the material was made. The result of this determination showed that the substance would not melt but instead it charred at 320°.
2. Tests for elements present gave the following elements as those present: (a) Carbon, (b) Hydrogen, (c) Oxygen (by difference). No other elements were present and the substance when ignited left no residue.
3. The material was treated with both concentrated and fuming sulfuric acid. In each case the only effect was that of charring.
4. Nitric acid was added to the

[12] J. Agri. Research 5 261 (1915).

[13] Organic Analysis, S. P. Mulliken.

substance and as no action was noticed it was heated. No effect was observed.

5. The substance was heated with the following reagents in turn: acetic anhydride, acetic acid, acetyl chloride, picryl chloride, hydroxyl amine. In no case was any change in the substance observed.
6. The material was heated with bromine. When it was redissolved in water and reprecipitated by adding an excess of alcohol it was unchanged.
7. Boiling with dilute hydrochloric acid had no effect on the substance.
8. Boiling with concentrated sodium hydroxide solution gave a dark black tar which would not crystallize from any solvent.
9. Tests for class reactions of the carbon, hydrogen and oxygen compounds were made. The substance was neutral and gave a reddish brown precipitate with Fehling's solution, which later was shown to be caused by the copper sulphate in the solution. A faint Molisch reaction for carbohydrates was shown. However, no carbohydrates listed in the literature were similar to the substance.
10. Silver nitrate was added to a solution of the material and a dark precipitate was observed. The solution was heated and filtered. The filtrate was evaporated to small bulk and cooled. No crystals were obtained by this procedure. It was then filtered and the filtrate found to contain only silver nitrate. The precipitate was then treated with ether, alcohol, carbon disulfide, carbon tetrachloride, petrolic ether and amyl alcohol but it was not soluble in any of these.

Copper Reaction Product

11. Copper nitrate was added to the aqueous solution of the material and a dark brown precipitate was observed. This was heated, filtered, and the filtrate concentrated as with the silver precipitate. Nothing was found in the filtrate except copper nitrate. The precipitate was treated with ether, methyl and ethyl alcohols, carbon disulfide, carbon tetrachloride, petrolic ether, amyl alcohol and glacial acetic acid but was not dissolved.

The copper nitrate product was carefully prepared by adding copper nitrate solution to a solution of the material. The mixture was heated and allowed to stand over night. The resulting compound formed settled to the bottom of the beaker and was removed by filtration. It was then washed with alcohol and ether and dried in the electric oven at 40°C. The melting point determination was made but the substance seemed to have no definite melting point.

The amount of copper present was determined in the following manner: approximately two-tenths of a gram of the substance was carefully weighed out into a porcelain crucible and ignited. When the ignition was complete the crucible was cooled and the residue dissolved in nitric acid. This was again ignited and when the ignition was complete the crucible was cooled in a dessicator. On weighing, the two analyses of the material checked rather well indicating practically uniform composition. The results of the copper analysis showed 10 per cent copper oxide.

Converting this copper oxide

into copper nitrate and taking the basis of one molecular weight of copper nitrate adding directly onto one molecular weight of the substance the material was calculated to have molecular weight of 612. This agrees fairly closely with the molecular weight obtained later by calculation from the combustions made to determine the carbon, hydrogen and oxygen, calculated to be 597.

The substance was carefully prepared and all the copper found was combined with the organic substance. As the material is so resistant to the action of the various reagents present, it is assumed to be added onto the copper nitrate and to not have the molecule affected in any other way. The copper may be recovered by suspending the copper nitrate product in water and passing hydrogen sulfide through the suspension. The copper is precipitated as copper sulfide and on filtering the reddish brown color of the original material is observed in the filtrate and it can be recovered by adding sufficient quantities of ethyl alcohol.

This evidence led to the belief that the material may be classed as a resin or possibly a pectin.

12. A quantity of the material was prepared in as pure a state as possible by repeated dissolving in water, precipitating by adding an excess of ethyl alcohol, washing with alcohol and ether.

An ultimate analysis of the material was made to determine the carbon, hydrogen and oxygen content. The results checked well in practically every case and were as follows:

	1	2	Average
Carbon ..	37.9%	38.0%	38.0%
Hydrogen	5.4	5.5	5.4
Oxygen ..	56.7	56.6	56.6

The simplest possible formula which would fit these results would be approximately $C_{19}H_{23}O_{21}$. Molecular weight determinations by the freezing point lowering method were made. As it was impracticable to analyze the solution, the method was to make a solution containing four grams per liter of water. This solution was placed in a test tube inside of a larger test tube containing alcohol to prevent supercooling. This was placed in a Dewar flask containing ether through which air was bubbled. The results obtained by four trials of this method were in no way satisfactory as they varied from over two degrees lowering to a fraction of the smallest division on the scale. The prevention of supercooling was hindered by the fact that one gram of the substance in 250 cc. of water gave so dark a solution that it was impossible to tell if ice were present. Also the method of adding small crystals of ice when the mixture was near the freezing point and making a cooling curve as ordinarily made in this kind of determination was tried but the results were still as unsatisfactory as ever.

Thus it was not possible to check the molecular weight determinations found by the copper nitrate method and the least possible formula method with the freezing point lowering method. The results of this work were as follows:

1. The coloring matter is not extracted from the soap stock or foots of cottonseed oil by any common organic or inorganic solvent which will not dissolve the soap stock. This causes the failure of any plan of isolation of the coloring matter which will

give results with other material containing vegetable coloring material. Possibly some of the coloring matter from the spent liquor in the manufacture of yellow soap from cottonseed foots could be isolated. This spent liquor is dark brown to black in color and contains very little soap.

2. The extracts of cottonseed hulls were made with ether, carbon disulfide, alcohol, acetone and benzene. When those extracts were analyzed with the absorption method they failed to show the presence of carotin, xanthophyll or closely related pigments. This result was checked by the spectroscopic examination and agreed with the work done by Gill in his work on the color tests for oils.
3. The extracts of cottonseed hulls made with the above solvents when combined showed very small amounts of gossypol as identified by the aniline and acetyl derivatives. However, the amount found present was exceedingly small, amounting to a fraction of a gram in fifteen pounds of hulls. This amount would have no toxic effect or at least the toxic effect would be so slight as to be negligible.
4. The water extract of cottonseed hulls was made and from this a substance was obtained which consisted of carbon, hydrogen, and oxygen in the proportions of carbon, 38.1%; hydrogen 5.4%; oxygen 56.5%. This substance was reddish brown and could not be decolorized by animal charcoals, etc. It gave no class reactions and was remarkably inactive towards most reagents. It gave a compound with copper nitrate and was acted on by caustic soda to some extent, giving a black, tarry mass.

Molecular weight determinations by the freezing point lowering method were not successful as they did not give reasonable results. The molecular weights calculated from the combustion and from the determination of copper in the copper nitrate were 597 and 612 respectively. The best formula fitting these molecular weights would be $C_{19}H_{33}O_{21}$. This compound is not listed in the literature and seems to belong in resin group.

Babassu Nut Oil

THE New York Journal of Commerce recently stated that, "The importance of the export of Babassu kernels in Brazil is steadily increasing, reaching last year the value of approximately $3,000,000, according to Commercial Attache Carlton Jackson, Rio de Janeiro. Europe receives almost all of it, only one ton being shipped to the United States. There is practically no shipment of oil from these kernels, the oil being made in the countries of destination where the residue, after extraction, is used as cattle feed and fertilizer. The oil is used for various purposes; in Denmark it is used for the manufacture of oleomargarine. A new Danish company has recently been formed for the purpose of trade with Brazil, the principle article desired being the Babassu kernels. Other countries that purchase quantities of the nut are Germany, Holland, France, Belgium, Portugal and Great Britain." Attempts to commercially introduce the Babassu nut into the United States have not been lacking, but so far, apparently, the results have been negligible.

It is claimed that Babassu nut oil is equal in quality to the oils for which it would substitute, but very little work with it has been done in this country, although Brazilian firms are anxious to do so.

Vitamins and Vital Elements *

Suggesting a Possible Chemical Basis for Vitamin Activity

BY JOHN E. RUTZLER, JR.

IT is the writer's belief that the action of the vitamins may be due, within certain limits, to their *inorganic constituents*. The limiting factor is that the metallic, or the non-metallic element shall be present in an available form. This means that the organic radical, if it is at all necessary for availability, may be any one of a number of different ones. For example, sodium xanthate may just as well make the sodium available as may sodium acetate, sodium oxalate, or sodium cholesterate.

From this point on, in order to attempt to get away from the mystery of the word 'vitamin' let us call these substances nutritional factors. Then, nutritional factor number 1 will correspond to vitamin A, and so on.

An explanation of the action of these nutritional factors on the basis of their elemental inorganic composition involves the consideration of salt ratios, body colloids, the permeability of body membranes, catalysis, mineral frothing agents, solubilities, and other biologic phenomena.

Elements Associated with Vitamins

Let us proceed to assign to each of the five nutritional factors, in an arbitrary manner, a given element, or elements. Then let us try to hold these elements responsible for the actions of our nutritional factors. To factor number one we will assign iron, to number two, manganese, to number three, zinc, to number four, calcium and phosphorus, and to number five, iodine.

Before attempting to justify these assignments, it is of interest to consider these and other vital elements in the light of the periodic table. Ignoring carbon, hydrogen, nitrogen, and oxygen, for the reason that they do not have vitamin action, in the atomic form, it is fairly generally conceded that the most important elements to normal body function are: sodium, magnesium, phosphorus, calcium, zinc, manganese, iron, potassium, and iodine. Of these elements, sodium, magnesium, and phosphorus are in the third period of Mendeléef's Periodic Table, whereas potassium, calcium, zinc, manganese, and iron, are in the fourth period. Iodine alone does not fall in either of these two periods, being in the fifth period. Fig. 1 shows the grouping of these elements in the Periodic Table. There are two distinct groups of such elements. It is interesting to note that in the right hand group we have two very versatile elements, namely manganese and iodine. Of all the metals manganese has the greatest range of valence, while among the non-metals, iodine leads in this respect. Another notable fact is that the elements in the left group have only one valence each. In contradistinction, of

* Continued from the September issue.

those in the right group each has more than one valence.

There are several reasons for the assumption that the active in the form of the ferric oxide hydrosol, $Fe_2O_3.3H_2O$. This is equivalent to two molecules of $Fe(OH)_3$.

Na	Mg			P			
K	Ca Zn					Mn	Fe
						I	

Fig. 1

principle of nutritional factor number one is iron. First of all, it was mentioned, under the discussion of vitamin A, that there is a relation between pigmentation and vitamin content. As was stated, it has been found that the more yellow a foodstuff is, the higher the vitamin A content. This may indicate iron, since iron is indispensable to plant life, and its tri-valent ion and many of its salts are yellow in color. Further, its oxide hydrosol can be got in a deep yellow form. Also, it has been found in spinach, the green color of which masks a strong yellow pigmentation. Coupling these things with the fact that spinach is rich in this nutritional factor, we have further evidence that iron is the important thing here, admitting at the same time that the major portion of the yellow color in the spinach is due to the presence of xanthophyll.

It is known that iron, in extremely small quantities, acts as a true catalyst in oxidation reactions, both within the body, and in entirely inorganic reactions.

Eminent physiologists believe that iron exists in the human body

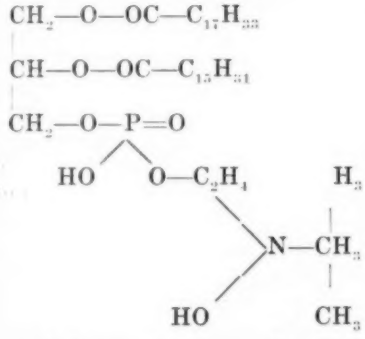
With these facts in mind we will attempt to show, on the basis of its iron content, why nutritional factor number one is beneficial to body growth. The process of oxidation, which is vital to living cells, depends in no small measure upon a substance which acts upon peroxides to liberate oxygen. This substance, which was thought to be an enzyme, is called peroxidase. Iron acts upon the cell peroxides just as does peroxidase. Pursuing this idea further, experimenters have found that peroxidases are exceptionally active forms of the metal iron, and in some cases of manganese. Also, it has been shown that in order to so function, the metal must have at least two valences. This situation is found in the right hand group of the table shown in Fig. 1. Iron oxide hydrosol is protected from coalescing by stable albumin colloids in some parts of the body[15].

In summary, it has been shown that iron is necessary for normal cellular functions, due to its catalytic action, and the subsequent production of oxygen. Therefore, normal body functions, since they depend on normal cellular func-

tions, must also depend upon the iron taken into the body. Since the evidence is in favor of the existence of iron in foodstuffs which are supposed to be rich in vitamin A, it can now readily be seen how iron could well be responsible for the growth-promoting action of factor one.

It is known that hæmoglobin contains iron. The amount of oxygen taken up by the hæmoglobin corresponds exactly to the calculated amount necessary to convert into FeO_2 all of the iron which is present. No such compound of iron is known. There are compounds of iron present, and they take up oxygen also. The important thing here is that there is a constant ratio of oxygen to iron.

To make this theory of value we must in some way show how iron may possibly be of assistance in the prevention and cure of xerophthalmia. We have seen that this disease is characterized by dryness and irritation of the eye. There is a cell membrane constituent called lecithin. It is closely related to the lipoids. It is a phospholipine, having the formula,



This substance is generally colloidal. In this form it is permeable to water and moderately dilute salt solutions. It has been found that flocculated lecithin is not permeable to water. The oxidation of lipoid films is catalyzed by iron salts. According to Mott, the electric potential of body cells is produced by the oxidation of lipoid films surrounding the globules.

Iron in Xerophthalmia

It is known that pathogenic bacteria cause xerophthalmia. The question which must be answered, is, "How does iron prevent and cure this disease?" For the normal function of the optic system a certain electric potential must be maintained therein. The iron sol may be precipitated due to the decreased potential which is caused by bacterial action. We make the assumption that the colloidal iron oxide is not protected by albumin in the optic system. The coagulated iron sol will then catalyze the oxidation of the lecithin in the cell membranes. As a result of this oxidation the H-ion concentration of the cells will rise, due to the formation of acids, and the electric potential will be restored to normal. The hydrogen ions present will then peptize the iron oxide back into solution.[16]. The oxidation of the lecithin will also provide the carbohydrates which are necessary for normal cell functions[15]. The oxidized lecithin will then be replaced by a new supply. Thus, we have shown how the disease may be prevented by the presence of iron.

When the bacteria are present and the ferric oxide hydrosol is not, the lecithin will probably be flocculated, due to the bacterial action. It then becomes impermeable to water, and the symptom of dryness appears. When iron is added in the form of nutritional factor number one, it proceeds to oxidize the lecithin. This causes the normal optic functions to re-

appear, due to the train of reactions discussed above.

We have assumed that iron is the controlling element in nutritional factor number one, and on that basis we have shown how iron could have the nutritional and anti-conjunctivitic properties that vitamin A is known to possess.

Manganese and Vitamin "B"

The case for manganese, as the controlling factor in nutritional factor two seems quite clear. It has been shown that manganese is as widespread in plant life as is iron, and further, that it is necessary for the normal growth of plants containing chlorophyll[18]. The element is therefore an essential part of the green things that are so abundant in our normal diet. Plants are a rich source of vitamin B.

There is another argument for the relation of manganese to vitamin B. Polished rice causes beriberi when it is the main source of nutrition, whereas the polishings contain the curative and preventive substance for this disease. Now, it has been found that the polishings are rich in manganese, while the rest of the kernel has a low manganese content. This seems to be a significant fact. The effects of feeding manganese to prevent beri-beri, to the writer's knowledge, have not been thoroughly investigated.

Manganese acts in the body oxidation processes as does iron. It behaves similarly to the peroxidase mentioned under the discussion of iron. It may be that the oxidations which are catalyzed by manganese are those which occur in the nerve cells. This would explain how this element might act in preventing polyneuritis, and in promoting general good health.

The starch and sugar contents of leaves that have become chlorotic because of lack of manganese, are much lower than those of the normal plant[18]. This is in accord with the fact that carbohydrates are formed in body oxidations catalyzed by manganese.

Another striking fact is that seed germs, which are so rich in vitamin B, are abundant sources of manganese[18].

The facts brought out above suggest that this versatile element is the contolling one in nutritional factor two.

Zinc Analogy Weak

The case for zinc as the responsible agent in nutritional factor three is not as strong as that for the other elements. There are only a few facts to support it. First of all, zinc is commonly found in plant life. It is known that zinc is helpful in the growth of an organism known as aspergillis. In the summer, cow's milk contains zinc, and milk is known to be a fairly good source of vitamin C. Acids protect this nutritional factor and alkalies destroy it. This is just what would be expected because of the amphoteric nature of zinc. To support the theory herein proposed those vital elements which are metals must occur in the basic-combining form. Thus, in the presence of acids the zinc would act as a metal and form compounds of the general formula ZnR_2. In the presence of alkalies compounds such as Na_2ZnO_2 would form, destroying vitamin potency.

At this point it is well to mention the fact that manganese is amphoteric, and that alkalies destroy nutritional factor two more readily than do acids. This would be predicted in the light of this theory.

Nutritional factor four is next to be considered. To this factor we have assigned calcium and phosphorus.

Salt ratios seem to be of prime importance in connection with the action of calcium and phosphorus in factor four. Salts of calcium promote the formation of a membrane which is too impermeable for the performance of normal vital functions. Salts of sodium exert the opposite effect. They prevent the growth of the membrane, or else make it too permeable to resist normal vital functions. "Balanced solutions like mammalian blood appear to be those in which the antagonistic electrolytes are in such proportions that the protoplasmic membrane formed possesses that measure of permeability most favorable to cell life"[19] Thus, when the Ca/Na ratio is not correct the permeability of the membrane is altered and the bones do not ossify normally.

The Role of Phosphorus

Phosphorus plays the role of keeping the ratio between itself and calcium correct.

When the Ca/P ratio is high it is possible that the Ca/Na ratio is thrown off by the excess of calcium which would then be present in the system. This would result in a higher than the normal amount of calcium, and the membrane permeability would then be such that normal vital functions would not proceed. Thus we see that phosphorus may be indirectly responsible for the maintenance of the proper Ca/Na ratio.

When the body is deficient in calcium it is possible that it may be supplied with that element in the form of nutritional factor four from vitamin D.

Ultra-Violet Reaction

The action of ultra-violet light in connection with factor four can be explained in two ways, either or both of which may be responsible. The calcium may emit electrons and become activated by exposure to ultra-violet light. In this way it could become more available in foodstuffs, or in the human system. Also, the most available form of phosphorus may be the colloidal form. It seems likely that ultra-violet light will peptize phosphorus.

Let us now examine the facts that are known about the fourth vitamin, and see how they fit in with the theory of action proposed above. Rachitis is caused by the failure of the bones to take in the necessary amounts of calcium and phosphorus. If the salt ratios in the body are not proper, membrane permeability will be such as to prevent the passage of these two elements into the bones. This would cause rickets.

Though cod liver oil contains very little mineral matter, it probably contains enough phosphorus to balance the Ca/P ratio in the body. Thus it may be of much use in the prevention and cure of rachitis.

The absence of the proper Ca/P ratio would make the body unable to use its own rich calcium deposits due to the resulting impermeability of certain cell membranes. Thus, when vitamin D is absent rachitis will develop.

The action of ultra-violet light has already been accounted for in connection with this vitamin. There is another possible way that these rays may act. They may catalyze a photochemical reaction, the product of which is phosphorus in an available form.

The fact that upon saponifying cod liver oil and removing the soap, the cholesterol which is left behind contains almost all of the vitamin content of the oil, can be explained. The explanation does not assume that the vitamin and cholesterol are closely related, but rather calcium cholesterate, and cholesterol phosphate form which results in these two elements losing their availability.

Vitamin "E" and Iodine

This brings us to the consideration of the anti-sterility factor. This nutritional factor is assumed herein to be responsible for its conduct to the element iodine. The important thing in connection with this vitamin is indirectly that within themselves all of the endocrine glands act alike.

At this point we will summarize some of the facts concerning iodine and the human system. Iodine increases the electrical conductivity of the tissues. Feeble quantities of energy are sufficient to make iodine pass from the state of a positive catalyst to that of a negative catalyst. When a thyroidectomy has been performed the response to stimulation ceases, and only sufficient electricity is generated for the processes essential to life. When iodized thyroid extract is injected into the system, sensitivity, and the power to do work return to normal. Iodine in the body increases membrane permeability and electrical conductance. Due to these two effects it increases metabolism.

Thus, it has been shown that iodine has profound physiological effects upon at least one of the endocrine glands. Since the organs of reproduction are part of the endocrine system of glands, and since within themselves all of these glands act alike, iodine probably exerts an effect on these organs. Thus, we see that iodine may be of prime importance to the normal reproductive functions.

Without iodine the thyroid and the rest of the endocrine glands cannot function properly. Therefore, it does not seem amiss to attribute to iodine the power to prevent and cure sterility. Conversely, the lack of iodine may be the prime cause of sterility.

Vitamin E is soluble in many fats. This fits in with the hypothesis that iodine is responsible for the anti-sterility action of nutritional factor five because many fats absorb iodine.

Summary

We have now shown how each of the elements assigned to the five nutritional factors may be responsible for the action that the five vitamins have on the human being and on animals, the case for zinc admittedly being weak. We have also shown that many of the chemical and physical properties known to be possessed by the vitamins are in accord with this theory.

This theory can be substantiated or disproved by the use of the too little utilized spectrograph. A brief outline of the procedure for doing this follows. The methods for all of the vitamins are identical, so an outline for one of them is given. A great many of the foodstuffs, known to be sources of vitamin A, should be examined. Spectrograms should be made of each of these foodstuffs in turn, using a spectroscope capable of photographing spectra in the ultra-violet region. According to this theory all of the spectrograms should show the presence of iron. Those materials

rich in vitamin A should show a higher iron content than those low in A content. This can be determined from the spectrograms. Next many foodstuffs known to be lacking in vitamin A should have their spectra examined in the above manner. This set of spectrograms should show little or no iron, if this theory is correct. If the theory is not correct, the foodstuffs devoid of vitamin A might show the presence of appreciable amounts of iron upon spectrographic examination. One should always be on the lookout for some element other than iron which may be common to all of the spectrograms of vitamin-A-containing substances; for the vitamin action might not be due to iron but to another element. Provided the spectrograms show what is predicted by the theory, another step is necessary before it can be called entirely valid. Animals suffering from conjunctivitis should be fed compounds of iron, and the effect noted. In this part of the procedure animals of the same kind but not diseased, should be used as controls. Both inorganic and organic iron compounds should be tried, also ferrous and ferric compounds. It might be necessary to intravenously inject these compounds into the animals. Colloidal iron and colloidal ferric oxide should be fed or injected. Provided these tests come out positive, this theory is entirely substantiated. If another element is found to be common to the vitamin-A foods as a result of the spectrographic examination, it should be fed as outlined above.

This procedure should be followed in the case of each of the vitamins, in order to obtain comprehensive supporting data.

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Ramifications of the Oil Industry

(Part II.) The Plant

BY THOMAS ANDREWS

TO those of you who have followed the first part of this paper it will come as no surprise to hear that there is practically no type of machine without representation in the oil world. It is not, however, my intention to catalogue the various machines that are used in the trade but rather to give some insight into the uses of the plant found in these works.

The oil industry in normal times is one of those industries that, once started, must be kept going, often without intermission, all year. Therefore we find in this trade some of the finest machinery that can be bought, and it is generally admitted that it is false economy to use any other. In the larger works it is usual to duplicate machinery that might, by its failure, bring whole sections of the works to a standstill.

The Power Station

The modern, up-to-date, oil mill and works generally has its own power station. There are no hard and fast rules regarding the type of prime mover that should be used and, in fact, we often see many types running side by side. I can give you a personal note on this matter to show you the extremes which can be met in actual operation. In a large works we had the following series of prime movers—there being a reason in each case why one was preferred to the other—the hydrogen production plant was run by gas engines working on the gas from a mond producer; the refineries and hardening equipment were electrically driven from power supplied by Diesel and Semi-Diesel engines; the extraction plant was run by a horizontal steam engine and the main power station contained turbo-generating sets feeding by electric current many processes scattered over a wide area. This instance shows that the power supply on a large works may take the power engineer through the whole gamut of prime movers.

Exhaust Steam Important

Exhaust heat is one point that needs careful thought when considering the type of prime mover to be installed. The old works using non-condensing engines exhausting to the atmosphere did give us, when properly used, a fairly continuous supply of low pressure steam. As outlined in the first part of this paper there is a large amount of vacuum evaporation done in an oil works and low pressure "waste" steam has great value. With the rise of condensing engines and the use of internal combustion engines this source of supply was lost, but recently another source has arisen. I refer to the use of "waste heat" boilers in conjunction with internal combustion engines. The hot products of combustion often leave the engine at temperatures up to 400° C when the engine is working at full load (the natural state of the load in oil works) and the heat discharged in the exhaust averages approximately 40 per cent of the calorific value of the fuel supplied. This 40 per cent can be used largely in the modern "waste heat" boiler to

give low pressure steam, and, as the load is continuous over large periods, such installations deserve close attention from the designers.

Types of Conveyors

The first process machinery that has to be considered comprises that which is used to get the raw material into the mill. The seed and other oleaginous material comes either by land or water and the unloading is generally accomplished mechanically. In the case of material brought by railway trucks a good procedure is to tip the contents into a pit from which it can be trimmed into elevators for transmission to a higher level. Handling by cranes and winches in bags and baskets is a slow, dusty business and absorbs far too much labor, although we do find conditions where it is the only feasible method. For small seeds the pneumatic or suction method has distinct advantages. It is, however, rather costly in power, and unless the bends are kept free from obstructions and the resistances in the suction pipe kept low the rubbing and bruising effect is likely to damage the seed—a point that is material when the seed has to be stored. However, the fact that flexible suction pipes make channelling and trimming unnecessary, gives a big advantage to this method as compared with the elevator.

For moving the material about on the level we have a choice between band conveyors and spiral or worm conveyors. For large and lumpy material such as copra, and for long distance travels the band conveyor is ideal. For short distances, and for moving material that is not damaged by friction the spiral conveyor is more adaptable. For material that is to be processed immediately and for material in the course of treatment there is no objection to the spiral conveyor, but where seed is to be stored for some time, then it is necessary to take into account the bruising action of such a conveyor.

Conveyors of all kinds play a big part in the economical running of an oil works. They place seed inside buildings, only as a preliminary. When the material gets inside the building it generally falls into an automatic weighing machine from which it is transferred by a band conveyor to a magnetic separator; it falls from this to the screens, the screened material falls into a pit from which it is removed by an elevator and is carried by band or worm conveyor to the silo; drops from the silo to the machines which remove the outer coverings, is carried from these in two parts—the husks to the boilers and the meats to the grinding machines—on conveyors; after rolling, the meats are elevated and distributed by hoppers to the kettles in the case of pressing, but taken on elevators and conveyors in the case of expelling and extracting; from these the extracted meal is taken on conveyors to the driers, the dried meal is taken on conveyors to the nutters and cubers, and lastly the finished nuts and cubes are fed to the bagging hoppers by conveyors. Surely a most important part of the running is effected by conveyors.

Decorticating Machines

The machinery used for removing the outer coverings differs with every class of nut and seed, and its efficiency is largely in the hands of the operatives, but in every case the mechanical efficiency is determined by that part of the machine which separates the various portions. It is of no use to find that

the shell or covering is detached from the oleaginous material unless at the same time efficient separation takes place. Each of the machines which do this part of the work can be divided into two portions, that which detaches the covering and that which separates the two. We have all, at some time or another, broken the shell of a Brazil nut and, unless there has been a clean breakage, experienced some difficulty in removing the bits of shell from the nut and the bits of nut from the shell. If, therefore, we can visualize the quantity of shell that would, in this extreme case, go forward with the kernel to the detriment of the cake and the amount of kernel that would be wasted with the shell, we can get some idea of the importance of the separation at this stage. The perfect machine would be the one which would give 100 per cent whole kernels and 100 per cent covering as two distinct parcels. Such perfection, however, is never attained. The condition of the seed plays a very important part in the separation. A "green" nut, i.e., one freshly picked, is generally found with the kernel fast adhering to the outer covering. As the seed or nut dries, the kernel shrinks inside the shell and the seed or nut falls out when the covering is broken. This being so, it is obvious that the condition must play an important part in the complete separation.

Rolling and Grinding

The next operation is that of rolling and grinding. Rolling of oilseeds is not undertaken solely with the object of bringing the material into as fine a division as possible, but with the object of freeing the oil from the tissue or sac in which it is contained. Therefore, it follows that not only must a grinding action take place but a tearing action must accompany it. In the old fashioned edge stones the action is one of perfection. The action of a parallel edge stone running round a fixed centre is, theoretically, impossible. Consider for one moment the inner and the outer faces of a parallel edge stone that is revolving round a fixed centre point and we find that the inner face is rolling round the circumference of a circle smaller than the outer face, the difference in the radii of the circles being equal to the width across the face of the stone. Therefore, since all parts of a rotating body equidistant from its centre of rotation must have a uniform velocity, and since these have not, they must fall to pieces.

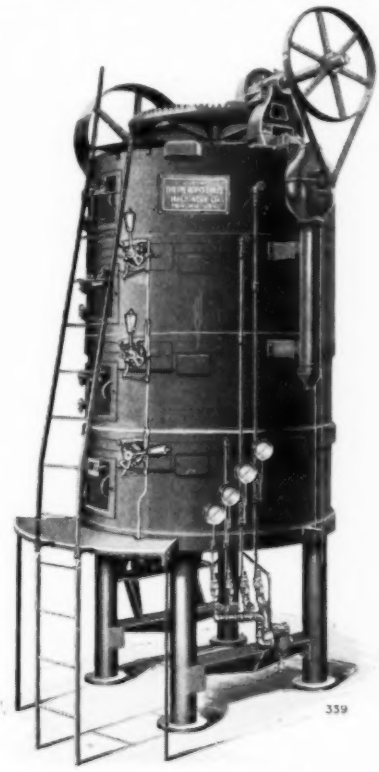
Edge Stone Action

Actually, in practical work we find that there is a certain amount of slip on the inner faces (shown by the tendency for all parallel stones to wear conical) that is very valuable, as it exercises the necessary tearing action on the material underneath it. The use of edge stones for the preliminary crushing of the seed has largely fallen into disuse, owing to their comparatively small output, and their place has been taken by rolls. The rolls are generally mounted five high, one above the other, the seed being fed from alternate sides as it falls from between any pair. To obtain the necessary tearing action the rolls are run at different speeds so that in any pair through which the seed is passing the one is pulling it through faster than the other. The effect is improved by cutting flutes or spiral rifles on the circumference of the rolls, these flutes being of different pitch on adjacent rolls. Where large nuts are to be treated, it is usual to pass them through ser-

rated, or hedgehog rollers to reduce the size of the pieces previous to rolling. The mechanism of the rolls is simple, the more interesting features being those which give a constant feed to the machine and the arrangements for maintaining the right pressure. The troubles which arise are due to uneven wear on the rolls due to the central portion doing more work than the extreme ends of the rolls and the pounding on the bearings due to the uneven opening and closing of the rolls according to the variations in the coarseness of the feed. Plain bearings are usually found on these machines, and it is doubtful whether there is any advantage in the roller bearing, due to the difficulty of maintaining the housings and rollers free from aggregation of dust.

Having obtained the requisite rolling, the seed is tempered in kettles to give the maximum yield of oil and to convert some of the starch into a colloidal condition to obtain a firmer cake. The kettle is a jacketed vessel fitted with agitators and possessing some method for damping the seed. This damping is usually done by injecting low pressure steam into the kettle while agitating. The kettles are of cast iron or mild steel plate, there being very little to choose from between the types. The kettling of the seed is purely mechanical and the plant calls for little comment. In those cases where the seed is to be crushed by hydraulic pressure, it is practically always tempered, but there is a growing tendency among the users of the worm expeller not to temper the meals. Those seeds containing gluco-cyanides should always be tempered, as heat releases the hydrocyanic acid radicle.

Where the meal is to be treated in hydraulic presses, it is next passed into a moulding machine where a known and constant volume of meal is pressed sufficiently to give the right size and shape cake to allow rapid and even filling of the hydraulic press. The moulding machine is essentially a ram or piston worked by hydraulic or steam power acting on a table free to rise and fall, a headplate being fitted to take the pressure. The rapid return of the table is arranged for, either by making the table sufficiently massive or by allowing the pressure to pass to the top of the piston at the end of the compression stroke. In the "Marseilles" system the moulding presses are

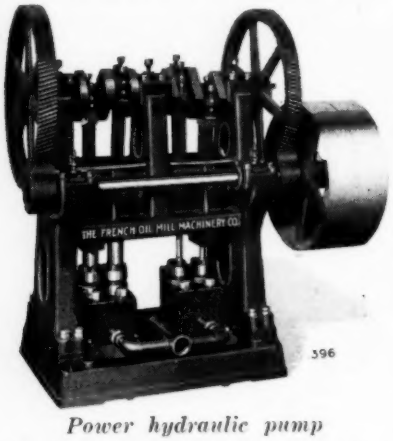


*Steam cooking kettle**

*Illustrations, courtesy French Oil Mill Machinery Co.

often made large enough to take a whole batch of meal for one pressing and to mould many cakes at one operation. I do not think this method as good as the single cake moulding, for it is easy to get parallel faces on the moulded cake in the case of the single press but extremely difficult to get parallel faces where a large number are moulded together, due to the "give" of the material. Cakes which taper in thickness cause endless trouble in pressing and often do damage to the press, owing to the setting up of uneven strains.

The hydraulic press is an adaptation of the "Bramah" press. A small plunger, pumping a certain amount of a non-compressible fluid into a receptacle containing another plunger, will pass on its energy to the second plunger and, subject to certain losses, the energy in foot pounds will be the same at the second ram as the first. As the rise in the second ram will be inversely as the square of the diameters, the total pressure under it will be directly proportional to the squares of the diameters of the two rams. Thus by making our ram diameter many times the size of the pump diameter we are able to obtain large pressures at the presses. Pumps capable of exerting pressures up to 7,000 lbs. per square inch are in use for seed crushing. This pressure is not as a rule used for the initial filling of the press nor for "taking up the slack," much lower pressures being used at first, and in some cases an intermediate pressure is used for the greater part of the time, the higher pressure being used only at the end of the time.



Power hydraulic pump

The pressure may be applied directly from the pump to the press. In this case there is a slight pulsation in the rise of the press due to the oscillating motion of the pump. In the other case the pressure from the pump is used to lift a load in a hydraulic accumulator which smooths out the pulsations before the load is applied to the press. Which is the better method is doubtful in oil pressing. Each method has its adherents who strongly maintain the advantages of their own particular method. Those who favor the accumulator method state that in the other method the oil is alternately squeezed out and sucked in after a certain point has been reached in the expression, and the other side states that the pulsation does give a larger yield of oil. The analysis of the cake and parings, however, does not show any marked difference, and so the matter can well be left to individual choice. In the case of long and continuous pressing at full load, such as we have in high titre stearine and wax pressing, I believe the accumulator has distinct advantages. The pumps and presses, provided no undue strains and stresses are set up, give very little trouble other than in the matter of the packing of the rams and plungers. Specially prepared leather packings are used to make a tight joint be-

tween the plunger and the pump barrel and between the ram and the cylinder. The life of a leather is an unknown quantity, but it is generally reasonably long when there is no scoring of the plunger or ram respectively. In the case of the cylinder and the ram the leather

Hydraulic accumulators

is inserted in a slot in the cylinder. Owing to the difficulty of fitting the leather, the slot is made deeper than the leather, the slack being made good with wooden packings. Water is seldom used in the system owing to its scoring action, but in its place a good, non-congealing oil of low viscosity is used.

The expeller, which has more recently been adopted for removing the oil, is a powerful adaptation of the old "sausage mill." A worm conveyor—working in a perforated cage—carries the meal against a cone obstruction. The cone is so set that the space surrounding it and the cage is insufficient to pass the meal as fast as the worm can bring it along. By this means pressure is generated and continues to mount up until a state of equilibrium is reached. At this point the meal at the given pressure can pass through the orifice. By inserting or withdrawing the cone varying pressures may be obtained. Above a certain pressure the oil will be forced out of the meal and will find its way out through the minute perforations of the cage. This oil is collected and drained away to the crude oil tanks. The expellers are belt driven and once they are set for any particular meal should be continuous in their working. They suffer from the usual defects, inherent in all machines where pressures are derived from worms, namely high friction followed by wear and heat generation.

That part of the seed which is to receive treatment by extraction is loaded direct from the rolls into enclosed tanks for treatment by the solvent. In all the plant that we have considered up to this point the action of the apparatus has been mechanical, but extraction involves another factor in that we have to add something to the meal to do the work—the plant being simply an accessory. The process depends on the oil being soluble in certain reagents which have no effect on the solid portion of the meal. The types of this plant are legion, but, in principle, they are the same. The principle is a very old one, and in the salt industry was in use for generations. In that industry water was pumped into saline earths and was recovered as brine solutions. These solutions were evaporated and the salt was left in the evaporator. The analogy is not quite perfect because the reagents used in oil extraction are valuable and have to be recovered for further use, whereas the water used to dissolve out the salt was permitted to go to waste.

Units of Plant

The plant consists of a vessel in which the solvent can be brought into intimate contact with the oily

material, a still in which the solvent can be boiled off, a condenser where the vapors can be condensed, a separator in which entrained water can be removed, and a store tank for the solvent. There are other refinements which have to be incorporated to prevent the loss of solvent and one of these is the washing or absorption chamber where the solvent can be recovered from the air driven out of the various vessels. This air is naturally saturated with the solvent vapors, the quantity varying with the outlet temperature of the air. The solvents most commonly employed in this country are petroleum spirit, the fractions of which boil between 90° C and 110° C (sold as extractor spirit), and tri-chlorethylene—a non-inflammable solvent boiling at 88° C. The extractor is a closed vessel of cylindrical shape with dish ends and may be mounted either horizontally or vertically. It is provided with agitating gear and contains some form of straining arrangement which will retain the solid material while allowing the oily solvent to pass through quite freely. Some method of introducing live steam into the vessel is also incorporated. The extractors are usually of mild steel boiler plate and there is nothing peculiar in their construction. Great care is necessary in the selection of the right kind of jointing and the right type of cocks and fittings, as the solvent is capable of dissolving quite a large proportion of the fillers used in making packings and penetrates the most minute orifices. Since many of the joints are subjected to the action of solvent, solvent vapor, oils, water and steam, we have added reason for the careful selection of the jointing.

The still may be either tubular or coil heated and may work under vacuum or not. It is a tall cylindrical vessel and may be either of cast iron or of mild steel. When it is heated by tubes these are of steel in steel plates. The plant is dependent on the still for its efficient operation, as it is here that the greater part of the solvent is distilled off and unless the still is kept efficient a fall off of efficiency may be expected all round. The chief enemy of the still is the fine solid matter that pulls through with the oily solvent. This soon coats the tubes and the coils, making it very essential that these should be periodically cleaned. The condenser is the most important item in the whole assembly. It is generally of the tubular type of surface condenser and in the better quality extraction plants is fitted with brass tubes and brass end plates, the outer casing being of cast iron. From the point of view of solvent loss, the success or failure of a solvent plant is bound up with the vapor velocity and with the cooling surface of the condenser. Provided the plant is free from leaks, a low vapor velocity combined with a generous cooling surface supplied with ample cold water will keep the losses of solvent within reasonable limits. The mixture of oil and solvent in the still does not readily part with the last trace of solvent, and it is usual to distill this off with the aid of saturated steam. In small installations this steam is generally admitted to the oil in the still, but as this means that from a solvent recovery point of view the still is practically inoperative, it is not adopted on large installations. As soon as the solvent recovered from the batch of oil in the still falls below a reasonable percentage of the normal, the contents are blown across to an independent tank where the oil is freed

from the last traces of solvent, the still, meanwhile, being freed for its more important duty of recovering solvent.

It is not usual, in England, to grind those cakes which can be fed to cattle, it being left to the farmer to break them as they are fed to the cattle. In the case of those cakes which are to be used as fertilizer, they are ground. The commonest form of grinder for this work is the disintegrator consisting, in its elements, of a series of fixed or hinged bars revolving at high velocity within a grid cage. The cake is fed into a hopper and passes into the body of the machine where it is beaten fast and furiously by the beaters until it is fine enough to pass through the bottom grid. The chief mechanical trouble is due to the wear of the the grids and care should be taken to see that in the type of disintegrator installed these are easily renewable. Those consisting of triangular sections run in with white metal and capable of being removed in short lengths are largely favored. The material being fed to these machines should be carefully looked over, as they are rather prone to strike sparks and sparks in the presence of fine combustible dust make as happy a combination as a flame in a powder magazine. Some meal is ground to be used in the manufacture of nuts and cubes for cattle feeding. The nuts are made by feeding the meal—either in a cooked condition or with some external binding medium such as molasses—through a pair of rolls each having half a die of the required shape cut into its circumference at numerous points. The cubes are made by the pressure exerted by a worm forcing the meal through a die, which in the presence of a binding medium causes the meal to extrude as a bar having the same cross section as the die. A revolving knife running against the face of the dieplate cuts the bar into the required length.

In the roll type of nutter there is little to give trouble provided that the two rolls are in alignment, but troubles due to wear and heat have to be guarded against in the worm type. The heat can be dissipated by jacketing the worm barrel so as to allow a current of cold water to surround it. The wear of the parts incidental to this type of machine calls for constant adjustment and finally for replacement of the worn parts.

(To be continued)

To Reopen Linseed Oil Plant

Articles of incorporation have been filed with the secretary of New York state for the resumption of business at the linseed oil plant of Kelloggs and Miller in Amsterdam, N. Y. The plant was closed some time ago because of the death of George Kellogg. The articles of incorporation were executed by Lauren Kellogg, the surviving member of the old firm, J. Arthur Brannock, C. Lauren Archer, W. Fenton Myers, and Edgar C. Bisbee, all of Philadelphia. The original business was established in 1824 by the grandfather of Lauren Kellogg, at Amsterdam, N. Y., and the mill was operated continuously from that time until the date of the shutdown.

Referee Applicants

The following applications for Referee Chemist certification have been filed with J. C. P. Helm, secretary-treasurer of the American Oil Chemists' Society: H. M. Shilstone (second publication).

The American tung oil industry in Florida is maintaining a steady rate of growth.

The American Oil Chemists' Society

Notes and Correspondence

Important Announcements

Reading Oil Colors

Mr. T. C. Law of the Chemists Committee writes: "I regret exceedingly that through an error in proof reading a mistake was not corrected in Rule 276, Section 1, (b), of the Interstate Cotton Seed Crushers' Association.

"The sentence 'Only one yellow glass and one red glass should be used to match the color of the oil,' should be the same wording as that in the old rule book, as follows: 'In every case where color standards are mentioned only the two standard glasses specified in the rule must be used to determine the grade.'

"It is the ruling of the Chemists' Committee that one yellow and two red glasses may be used to match the color of the oil.

"I understand that most of the electric houses are discontinuing the manufacture of a 75 watt daylight lamp. As there was found to be no difference between the readings with 75 watt and 150 watt, I see no objection to substituting a 100 watt lamp for the 75 watt.

"Your very truly,"

(Signed) Thos. C. Law.

Standardization of Color Glasses

Members wishing Lovibond glasses standardized by Bureau of Standards may send them to Mr. A. W. Putland, c/o Portsmouth Cotton Oil Rfg. Corpn., Portsmouth, Va. Only red glasses will be taken at this time. The fee will be $1.50 per glass.

Members who wish to send glasses directly to the Bureau of Standards, Washington, may do so. The fees are: For a single glass submitted alone .....$10.00.

For any lot of glasses submitted together and covered in one report, $10.00 for the first glass and $1.00 each for each additional glass in the lot, as illustrated in the following table:

No. of glasses in lot	Total fee
1	$10.00
2	11.00
3	12.00
etc.	etc.

Second Fall Meeting

The second Fall meeting of the Society will be held in New York, October 25th and 26th, at the McAlpin Hotel. Special rates have been arranged as follows:

Single room with bath $4.50 per person per day.

Double room with bath $4.00 per person per day.

Two double rooms, connecting bath $3.50 per person.

Joint Committee Announced

A joint committee on the analysis of commercial fats and oils was recently announced by the American Oil Chemists' Society and the American Chemical Society. It is headed by W. D. Richardson as chairman and includes the following: W. H. Irwin, secretary; R. W. Bailey, T. C. Law, C. P. Long, H. J. Morrison, M. L. Sheely, L. M. Tolman, H. P. Trevithick, J. J. Vollertson and David Wesson.